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STATE OF INDIANA

Fourth Annual Report of t

State Board of Forestry

1904

W. H. Freeman
Secretary

TO THE GOVERNOR OF INDIANA

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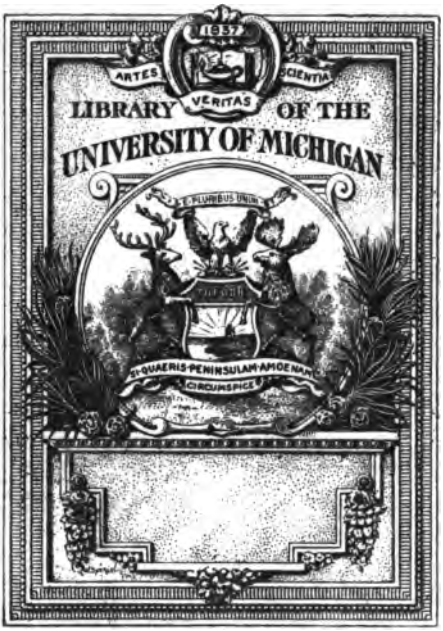

THE GIFT OF
Ind. board of forestry.

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OF MICH.

An institution which is rapidly passing out of existence in Indiana, but which in its day has consumed enough valuable oak, walnut, poplar, hickory, ash and other valuable timbers to purchase the larger part of the land in Indiana if now standing and at the present prices for prime trees such as were then used.

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STATE OF INDIANA

FOURTH ANNUAL REPORT

OF THE

STATE BOARD OF FORESTRY

1904

W. H. Freeman, Secretary

TO THE GOVERNOR OF INDIANA
WINFIELD T. DURBIN

INDIANAPOLIS:
WM. B. BURFORD, PRINTER AND BINDER.
1905.

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THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
December 13, 1904.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 13, 1904.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

D. E. SHERRICK,
Auditor of State.

DECEMBER 13, 1904.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

GEORGE B. LOCKWOOD,
Private Secretary.

Filed in the office of the Secretary of State of the State of Indiana, December 14, 1904.

DANIEL E. STORMS,
Secretary of State.

Received the within report and delivered to the printer December 14, 1904.

THOS. J. CARTER,
Clerk Printing Bureau.

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INDIANA STATE BOARD OF FORESTRY

OFFICIAL MEMBERS, 1904

FINLEY C. CARSON, President.....Michigan City
STANLEY COULTER.....LaFayette
ALBERT LIEBER.....Indianapolis
JOHN COCHRANE.....Indianapolis
WM. H. FREEMAN, Secretary.....Wabash
MRS. ELLA GROW, Stenographer.....Indianapolis

Office of Secretary
Room 93, State House, Indianapolis.

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STATE OF INDIANA, BOARD OF FORESTRY,
Indianapolis, Ind., December 1, 1904.

Hon. Winfield T. Durbin, Governor:

Dear Sir—In accordance with the law by which the State Board of Forestry was organized, we have the honor to submit herewith the manuscript of the Fourth Annual Report of the work accomplished the past year, discourses for forest cultivation and recommendations for legislation to better promote the institution of forestry within the State as in the judgment of the Board seems expedient.

Yours respectfully,

F. C. CARSON, President.

W. H. FREEMAN, Secretary.

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FINANCIAL STATEMENT

November 1, 1903, to October 31, 1904

ANNUAL APPROPRIATION BY ACTS OF GENERAL ASSEMBLY, 1903.

Office:	
Salary of Secretary	$1,800 00
Salary of Stenographer	600 00
Salaries of four Board members, each $100	400 00
Mileage of four Board members	67 56
General expenses of office	1,000 00
Total	$3,867 56
Forest Reservation and Experiment Station:	
Expenses of management and labor of	$3,000 00

EXPENDITURES.

Office—salaries and mileage:	
Salary of Secretary, W. H. Freeman	$1,800 00
Salary of Stenographer, Ella Grow	600 00
Salary of Board member, F. C. Carson	100 00
Salary of Board member, Stanley Coulter	100 00
Salary of Board member, Albert Lieber	100 00
Salary of Board member, John Cochrane	100 00
Mileage of Board members	67 56
Total	$2,867 56
Office—General expenses:	
Field work (reports and maps) for use in office	$438 50
Office fixtures, telephone and incidentals	209 43
Photography and photographic supplies	37 27
Mileage and livery	67 00
Postage	150 00
Printing and stationery	97 32
Total	$999 52
Balance	48
Forest Reservation and Experimental Station:	
General management expenses and supplies	$1,171 10
Labor	1,777 55
Seeds	51 35
Total	$3,000 00

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A view showing a type of forest remaining in Indiana at the present time.

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PREFACE

The work accomplished by the Indiana State Board of Forestry the year just past is more extensive and far-reaching than can be definitely stated in this report. A goodly amount of information has been ascertained and given out from time to time through correspondence and newspaper articles. A vigorous crusade of agitation of the subject has been carried on almost constantly in all parts of the State, and the importance of forestry advancement and forest protection is uppermost in the minds of the people in every locality. There has been formed a strong sentiment of appreciation for the cause, which will sooner or later ripen into sincere and concerted activities. Men and women possessing notable recognition for thought and intellect are observing and studying the problem and the conditions and are formulating plans and shaping advice as to the best course to pursue in the prosecution of forest enterprises within the State.

A great number of addresses on the subject of forestry were made at both private and public gatherings of various kinds. At Farmers' Institutes, educational assemblages, club organizations, associations of horticulture and agriculture and conventions, topics of forestry were given prominent places on the programs and in the discussions. These elements are the most hopeful indications for the success of the cause, and they reveal the mind of the people. Although the difficulty of finding a timber supply for the uses of the manufacturing industries affords a great temptation, because of the good price offered for forest owners to dispose of their timber product, there is vastly less of the sentiment and disposition to minimize the woodlands. There is forming strongly and surely a disposition to carefully guard the present forests and a maximum tendency to dedicate and reforest the cheaper broken lands. The thoughts are becoming rapidly adjusted to the dangerous condition into which the country was drifting, and in every community are found men who are thoroughly awakened to the

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necessity for immediate activity and because of their wider vision and greater forethought they are sounding a warning note against the ruthless forest destruction.

When the far-reaching results of the past neglect in handling forests is seen the first thought, perhaps, is to remedy the evil to the extent of preventing future recklessness by legislation. The thought would be to legislate men into doing that which their own intelligence should know is the right thing for them to do. The Board has found it necessary in the past to seek some legislation in order to have a fitting foundation for it to become an effective body, and it sees wherein other legislation will be beneficial in the future and the same will be discussed in this report. It is not, however, in any sense the idea that right forestry can be legislated into existence. It is activity and not law which will solve the forestry problem, but legislation can be enacted which will induce activity, and that shall be the aim sought by the Board in all legislative attempts. The greatest efforts, therefore, by the Board have been directed to the stimulating and the awakening of the minds of the people to the conditions of the necessity for and the best methods and plans to follow. It feels that these elements, rightly instituted with the people, are more important than laws. The members of the General Assembly are keenly alive to the best and highest interests of the people and the State, and when the suggestion is made that the forest problem is one of the most important problems to solve in connection with the welfare and progress of us all they will investigate the matter, use their best judgment and enact just and suitable laws.

The discourses herein submitted, as well as the illustrations, are aimed to suggest and guide those who may wish to engage in forestry work upon their own lands. The constant aim in all directions of means and methods are simplicity and practicability.

The Board unqualifiedly acknowledges its obligations to the public-spirited citizens of Indiana in the ways before stated for the successful forestry achievements to the present time. In particular is the Board under obligations to the public press, the retiring Governor, Winfield T. Durbin, and his associate members of th State Printing Board. The press has been more than liberal with its columns, and the Governor, with his associates, have been

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very liberal, yet conscientious and business demanding in their support of this worthy movement.

In conclusion, the Board urges an increased activity and interest in forestry by the entire people. It urges, however, that more attention be given to stable forest plantings of the commercial hardwoods, such as the industries will demand in the future. Investigate the cheap land sections of the State and establish forestry estates. Surely in this there are great opportunities.

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REPORT OF EXPERIMENTS, IMPROVEMENTS, CONDITIONS AND REQUIREMENTS

AT THE FOREST RESERVATION AND EXPERIMENTAL STATION AT HENRYVILLE, CLARK COUNTY, IND., TO DECEMBER 1, 1904.

SEEDS—TREATMENT AND PLANTING.

The walnut, hickory, oak and black locust seeds which were stored by stratifying them in sand in the fall of 1903 were taken from storage and planted at different periods of time in range from May 6th to 30th this last spring, 1904. The ash, lin, catalpa and pine seeds, which were secured at the same time and stored in a dry, cool room, were also planted during the same period of time.

The extent and the result of these experiments must be considered from the view that the season of 1903 was a very poor one for securing either a good quantity or a good quality of seeds, as stated in last year's report.

The storage experiment was a success in every way so far as seed effects were concerned. Large box beds were built upon the surface of the ground in the open and upon a well-drained site. In these were placed alternately layers of seeds and sand until they were filled. Sand enough was placed over the lower layers of seeds to imbed them completely and to afford a solid encasement for holding the moisture. Over the last layer, at the top was placed a covering of from three to four inches of sand to prevent the upper layers from drying out and thus hinder the killing of the germ by the alternate moistening and drying of the seeds, as would result by reason of the alternate changes in the climate. No straw or other mulch was placed over them, as it adds to the enticement of rodents, which are always to be guarded against in seed storage. The seeds were permitted to receive all the weathering from December to the time of removal for planting, approximately five months.

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When the seeds were removed from the storage the results were very decided. All the poor seeds were rotted or the defects so developed that there was no difficulty in detecting them. The good seeds were in a splendid condition and in the full vigor of germination. By placing the seeds when removed into vessels of water complete separation of the good and bad seeds was accomplished. The former at once sank and the latter floated and were cast away.

The approximate amounts of bad seeds as determined by this treatment were as follows: Walnut, 10 per cent.; hickory, 20 per cent.; oak, 60 per cent.; chestnut, 50 per cent., and locust 0 per cent.

A condition arose in this feature of the work which was unlooked for and which will be given to guide others from a like occurrence. The season of last spring was decidedly rainy and thus prevented the preparation of the ground for planting as early as should have been to receive the seeds before they attained a too advanced state of germination, as forest seeds germinate very early if moisture and light is afforded them. As a consequence many seeds were lost in removing them from storage by their falling apart or the destroying of the sprouts, as many when removed were far advanced both in root and stem. As soon as the conditions of the seeds and the climatic probabilities were appreciated every effort was made to push the land preparation and retard the seed germination. The storage beds were covered with boards to shut out the light. Had the climatic conditions been foreseen and this precaution taken early the advanced germination could have been overcome to a large extent.

Another thing occurred which prevented the extent of both storage and planting. Eight bushels of acorns secured in Tennessee from a seed firm, were not properly cured before shipment, and after being placed in bulk for shipment, and because of delay en route, became heated and sprouted until worthless when they arrived and were rejected, and thus limited the quantity of acorns for storage to but two bushels which after the tests left but a small quantity for the planting.

The planting of the seeds was performed in the most simple and speedy manner. The abandoned, worn-out fields were prepared in the same manner as for corn planting, except the ground was

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not thoroughly pulverized and was crossed off at greater distances. When the ground was well plowed or disked, as was done, a marker was made of heavy oak plank and steel to perform the work of checking the rows. It was made in the form of a sled with the runners plated with steel drawn to a cutting edge in front and widened to a distance of four inches at the back. By this device and a good team the ground was well and speedily prepared. The planting was at distances of five feet apart each way. Men with apron sacks filled with seeds and suspended in front of them from their shoulders dropped the seeds into the checks and with ordinary farm hoes covered them. The seeds were brought from storage directly to them and at no time were they permitted to become dry before they were planted. The kinds of seeds planted on a field or a part of it were determined by the soil character. Adaptation of soil and seed were observed, though as an experiment, to fully determine that a tree will not do any good or only fairly good on a certain soil, and a given condition was thought to be worth almost if not as much as to know the affirmative result, and thus departures were made from the observance.

The plantings were both pure and mixed, as shown by the following descriptions:

1. Eight acres black walnut, planted on porus, sandy, clay soil of 700 feet average elevation.

2. Four acres walnut and chestnut in groups of rows each, planted on porous, sandy, clay soil of 630 feet average elevation.

3. Seven acres shellbark hickory, planted on hard, sandstone, clay soil of 600 feet average elevation.

4. Seven acres shellbark hickory and chestnut planted on sandstone, porous, clay soil of 620 feet average elevation.

5. Five acres shellbark hickory and white oak planted on hard, sandstone, clay soil of 600 feet average elevation.

The first of these plantings is far more successful, to the present, than any of the others. A splendid rain fell soon after it was done, and within ten days thereafter the young walnuts were shooting through the ground in almost a perfect stand. Two seeds were planted in a hill and were placed about two inches apart. This number was planted in a hill to insure a perfect stand on the planted area, with the idea that if they came well thinning could be done and the young seedlings transplanted to the vacant spaces

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A view showing a section of the seedyard at the Forest Reservation and Experimental Station.

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and other fields to determine the success of transplanting walnut seedlings.

The seeds came and grew almost perfectly, and the work of digging and transplanting the excess seedlings will be done the coming spring of 1905. The only notable loss from a perfect stand is due to the squirrels, which dug the seeds up and carried them away on the parts of the fields next to the timbered areas.

At this same time, and under the same conditions and by the same methods, were planted two acres of dry, unstored walnuts. Up to date there are no signs of growth from these seeds. The inference is that they will put forth next year. This instance affords splendid argument for the storage of walnuts before planting.

The other plantings did not do so well. The oaks and the chestnut were more advanced in germination than the hickory and walnut, and hence were more liable to injury from the removal and planting. For almost ten weeks after planting the last fields no rain at all fell, and none of any decided consequence came till the last of September from the time of the planting. It is a matter of record that such a drouth has not been known in that vicinity for more than fifty years, though drouth is common to the locality. Because, then, of these conditions over which man has no control, many of the seeds perished before any perceptible growth or soon thereafter. The walnuts and hickory nuts were more hardy against such conditions, and since the rains of the late summer and autumn are coming through the ground in splendid numbers. Of the plantings the following per cents. may be given as fairly accurate for the stand of seedlings obtained: Walnut, 90 per cent.; hickory, 75 per cent.; chestnut, 30 per cent., and oak, 20 per cent. All conditions considered, the results are good and afford good hopes for excellent results under more fair conditions.

The growth of the seedlings has suffered from the same causes of drouth as above given. Except the walnut the seedlings are in all stages, from just coming through the ground to eighteen or twenty inches high. The only cultivation which was given them was with the harrow. The ground was left unpulverized at the time of planting. During the summer a weighted harrow was dragged over the ground, straddling the rows, and by this method sufficient cultivation was given to keep down the weeds.

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The ash, lin, catalpa, locust and pine seeds which were sown in the nursery made no progress. They simply burned in the ground, so that the nursery effort may be classed as a failure. No irrigation means were at hand to facilitate this feature, and the effort will be renewed this fall.

Ash seeds were sown broadcast along the streams also during the last spring, but no results are visible at this time. It may be that later results will develop.

A view showing the method of seed planting on the fields at the Forest Reservation.

With the above conditions and results in mind the Board has decided to plant the seeds this fall, 1904, instead of storing them in sand and again risking the climatic conditions of another spring season. Owing to the excessive drouth of the past summer good seeds are not available in the locality, and from the same and other reasons good seed can not be found in any part of the State

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or the adjoining States. Enough good seeds, however, by great effort have been obtained to perform the following plantings:

1. Thirteen acres mixed oaks, shellbark hickory, chestnut, walnut, ash, cherry and lin, planted in sandy, porous, clay soil of 520 feet average elevation.

2. Eighteen acres walnut, mixed oaks, shellbark hickory, chestnut and cherry, planted in sandy, porous, clay soil of 560 feet average elevation.

3. Twenty-five acres shellbark hickory, cherry, mixed oaks, chestnut and ash, planted in hard, sandstone, clay soil of 620 feet average elevation.

4. Fifteen acres shellbark hickory, mixed oaks, ash and walnut, planted on sandy, porous, clay soil of 580 feet average elevation.

5. Fifteen acres mixed oaks, cherry and shellbark hickory, planted on hard, sandstone, clay soil of 590 feet average elevation.

6. Fifteen acres of nursery of every kind of seed included in the above plantings, and locust, poplar, sycamore, pine, mulberry and catalpa in addition.

All seeds planted on the above areas were tested in water to avoid planting defective ones. The test showed the following approximated per cents of bad seeds: Acorns, 40 per cent.; hickory, 20 per cent.; chestnuts, 20 per cent.; lin, 60 per cent.; cherry, 5 per cent.; walnut, 5 per cent.; ash, 20 per cent.; mulberry, 2 per cent.; coffeenut, 0 per cent; pecans, 5 per cent., and pine, 3 per cent.

The extent of seeds secured to date is as follows: Forty-eight bushels of mixed acorns, 2 bushels of lin, 2 bushels of cherry, 15 bushels of shellbark hickory nuts, 8 bushels of chestnuts, 200 pounds of ash, 100 pounds of locust, 2 pounds of mulberry, 50 pounds of Kentucky coffee tree, 10 pounds of Texas pecans and 5 pounds of white pine. Nearly all of this quantity was secured outside of Indiana.

The field plantings were at distances of five feet apart each way, with the two exceptions, and the different species of seeds were planted in alternated rows or groups of rows. The nursery was planted by drilling the seeds thickly in rows at three feet apart. In all the work the ground was prepared in splendid shape by the same methods as in the spring plantings.

As many seeds as can be secured will be stored in sand for planting in the spring, 1905.

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No definite conclusions are to be drawn from the work so far accomplished. There are not enough premises from which to deduct a right opinion, but the evidence so far is favorable to the renewal of forests on denuded lands by seed planting at small expense.

FOREST CULTIVATED.

The work of cultivating the forest area of the Reservation, as begun last year, was carried on as fast as the means would permit in connection with the other lines of work. About eighty acres were gone over the past summer. All the inferior trees, the worthless species and the excess over and above the number desired to form the permanent forest were cut out. Those left standing were pruned as seemed right for their best development and all the brush was leveled close to the surface to form a covering and rot into mold and form humus to retain the moisture and enrich the soil.

The work of this kind which was performed last year indicates by the good development this past summer that the plan is both right and necessary. The cutting out of the excess and worthless trees and the pruning afford such vastly greater chances for the trees remaining to develop that there can be no question as to its being the thing to do. The fact that the development is there and can be so plainly seen by any one is evidence for the argument that all the forested area should receive the cultivation treatment at the earliest possible time.

The indications at this date are that the summer and autumn are the best seasons to do the work. The sprouting from the stumps and the healing over of the cuts made in pruning is far more satisfactory when the work is performed in the summer and autumn than where it is done in the spring months. The winter time up till March is very satisfactory in the same points but not so satisfactory in completeness. In the winter time it is difficult to locate all the dead and dying trees and the different species which should be cut out owing to the absence of the foliage. The past year has shown that the work can not be successfully done in winter.

Scarcely a tree died from the cultivation effects last year. A few show the effects of the cultivation of the past summer. The

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leaves withered and to all appearance the trees are dead, though the spring time may see their leaves put forth. The number thus affected is so very small that it attaches no significance of data against the theory. Taken in conection with the excessive drouth of the locality it is marvelous that so few were affected.

The only damaging evidence against the work is the opportunity afforded for disastrous fires. Every precaution is taken to guard against them. Notices are served on all land-owners adjoining the Reservation every September, which is the beginning of the season for starting fires. If fires can be avoided for a few years the danger will be over. Great credit is due the citizens of the community for the care they are exercising in guarding the Reservation against this danger. Considering the recklessness of former years in spreading fires in the same community it is significant to notice the interest manifested by them against fires in the entire vicinity. An incendiary spirit or an accident would be the only excuse for a fire's origin under the existing strong sentiment of the community for the success of the institution. A constant guard is kept by the employes during the danger season and better safeguards should be speedily perfected for controlling fire should it ever occur. Fire lines and drives should be made systematically throughout the Reservation.

FOREST UNCULTIVATED.

There remains of forest uncultivated about 1,200 acres. Four hundred acres is broken knob land and 800 acres is fairly level land. The entire area is densely grown up and should be cultivated without delay. There is scarcely any timber large enough for a good market value, but a splendid stand of the best hardwoods of from a few years to twenty years' growth is found on every acre of the area except in a few localities on the knobs where white pine of an inferior quality is abundant, and which is now coming into demand for railroad cross-ties, which, after being treated chemically, gives good use for such purpose. The extent of such pine areas aggregates about one hundred acres.

The condition of the greater part of the forested area which is uncultivated is a devastated one. It is a jungle of undergrowth composed of bad and good species in a dual strife for survival. It contains the rubbish of years of timber cutting, dead and in-

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A view showing a portion of a cultivated woods on the Forest Reservation. This view shows the stand of prime hardwood trees retained after the excess and worthless trees have been taken out and the brush leveled to the ground. It was taken a year after cultivation and shows how well the brush levels and decays into humus and prevents undergrowth.

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A view of an uncultivated woods on the Forest Reservation which is a type of the 1,200 acres which should be cultivated at the earliest date for its proper advancement.

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jured trees by fires and storms, and briers and vines entangling all. Proper development of the desired, valuable species can not be expected until relieved of the hindering growth and rubbish. If this is done a fine stand of prime trees can be secured on all of the forested tract, and within a few years the cultivation will give them such an ascendancy as will enable them to overpower the excess and worthless growth.

The cost of doing this cultivation is about three dollars per acre. The income which can be derived from the fuel and such

A view of an abandoned field showing how it grows up in sumac and other worthless trees.

other sales as can be made will perhaps pay for doing the work.

The Board has spent none of its funds in attempting to market any products. Other work was more pertinent. An experiment was made, however, to determine the income which might be obtained from a frugal cultivation of the timber land and the marketing of the product derived therefrom. Portions were permitted to be cleaned up for the product, and a careful observance of the results justify the statement that for the greater part the cultivation of the woodland in the manner discussed heretofore

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will return a dollar for every dollar so employed. The State would simply be loaning the money for the time it takes to do the work and remit. The gain to the forest thus relieved would surely justify the loan.

CLEARED LAND—UNCULTIVATED.

There remains of cleared land which has received no cultivation and which was abandoned by former owners for agricultural purposes, about 400 acres. It must not be understood that this land possesses no growing value, but that, having been farmed successively until weakened in producing strength, it was forsaken for new clearings. These fields were permitted to grow up for the most part in sassafras, sumac, briers and similar valueless species of plant life as usually take possession of abandoned land of its nature. Other portions are barren and very much eroded. These fields have received no attention for cultivation since becoming State property because every effort of the Board has necessarily been directed to the organization and the improvement of the tract and the immediate forestry work. The condition of the land, together with the limited demand for rental lands for farming has made it impossible to have the fields cultivated. It is desired that all these fields shall be put under forest cultivation at the very earliest time to prevent their becoming too waste and thus incur a large expense to reclaim them.

CLEARED LAND—CULTIVATED.

The cleared land which has been cultivated the past season is about 200 acres. Of this amount, as has been stated heretofore, 32 acres were planted in forest seeds this last spring and 101 acres were planted this fall. About 170 acres in the aggregate were rented for tomatoes, corn and oats this season at such rents as could be obtained, depending on the condition of the land. The planting done this fall was on the land cultivated in crops this season and performed after the crops were removed. From this source a small revenue will be derived, which will be paid into the State Treasury when received. Grain and roughness enough will be secured also from this source to feed the teams of the Reservation for the next year. The main items sought in renting the land this season were to get the ground prepared for plant-

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ing and reclaimed from waste without much cost, as the ground is easily prepared after the crop is removed. This device was resorted to in order to accomplish as much with the appropriation as possible and to get all the lines of work under way. Much more would have been derived in returns from the rents had the season been favorable. Under the drouth conditions the crops were almost a failure. It is hoped to accomplish more from rents another season.

TREE PLANTING.

There were bought from a Wisconsin nursery company and planted last spring on the slopes and knob lands 10,000 standard white pine seedlings. Men with bundles of the small trees traversed the knobs and slopes and with hand-dibbles made excavations and planted them promiscuously in the favored places. It is feared, however, that the damaging drouth had its effect upon them as it did upon the seeds. Just what per cent. of them perished is not known and can not be ascertained at this time.

The grounds surrounding the buildings on Grandview Knob were carefully plotted and planted with trees for decorative purposes this last Arbor Day. Elm, ash, lin, gum, poplar, mulberry, maple, oak, pines and spruce were planted. There were 200 of such trees planted. These trees were of good size. Part were nursery-grown and part were forest-grown. The public schools of the township (Monroe) in which the Reservation is located and the citizens of the community turned out en masse and celebrated Arbor Day at the Reservation and participated in this tree-planting. Adjoining townships also sent delegates from their public schools to participate in this work.

The day is not to be forgotten, marked as it was by the high sense of appreciation and decided interest manifested by all present, and the Board kindly acknowledges the obligation and the service rendered them upon this occasion.

IMPROVEMENTS.

The improvements at the Reservation were forwarded as far and as completely as the appropriation would afford. They consisted of road-building, tearing away the old fences and grubbing out the old fence rows of years' standing, removing the old buildings and cleaning up the premises around them. The seventeen

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farms, with their buildings and adjuncts, have been transformed into one tract of 2,000 acres without inside enclosures and buildings.

The road-building has consisted of the blazing and the cutting out of such roads as afford ingress to the main features of the site, putting in sewer and bridge crossings over the streams and ravines, together with the necessary gradings to the same and the widening and the repairing of the Knob road built to headquarters last year. A road was blazed, chopped out and crossings put in over the streams and ravines extending from the public highway on the eastern border through the mainland of the Reservation to the foot of the Knobs and connecting with the Knob road, thus affording a fairly convenient opportunity of driving to observe the main features of the tract. Additional roadways were outlined to enable access into other parts of the woodland. None of these roads are in any sense complete. They are crude, but all that could be accomplished.

The crude, old fences which were numerous on the site and were permitted to become dilapidated and densely grown up are, with few exceptions, now removed, and add a great deal to the appearance of the tract.

The buildings, which, like the fences, were permitted to go into decay or else were crude cabins, were razed and burned or permitted to be hauled away. The premises surrounding them were cleaned up so as to obliterate any disconnection with the tract as a whole. The fruit orchards were pruned and retained.

These latter improvement features, next to the forest cultivation, are the most impressive in elevating the appearance of the tract.

THE PROPOSITION.

The proposition which confronts the Board, and which it places before the people of Indiana for their consideration and decision through their representatives, the Governor and the members of the coming General Assembly, is one of the things to be accomplished; and the Board recommends that sufficient funds be appropriated by the coming General Assembly to do these things. The Board feels its own sense of honor and justification in the requests submitted and invites investigation. The whole proposition, stated in its parts, are as follows:

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1. Twelve hundred acres of forest, which should receive systematic cultivation at the earliest date.

2. Four hundred acres of abandoned fields, which should be planted in seeds and trees without delay.

3. One hundred and thirty-three acres of land planted in seeds, which will require careful cultivation for the next few years.

4. Six miles of main roads, which should be built in a good, systematic manner, and double as many miles of lateral roads and fire lines for ingress and for fire protection.

5. Water reservoirs systematically established at different places on the Reservation to facilitate the plantings in time of drouth and as an essential adjunct to fire protection.

6. Border line fencing between the Reservation and adjoining land-owners, the one-half of which the owners themselves must build.

7. The erection of two and the remodeling of one residence building for the permanent employes needed constantly on the Reservation, and also, the building of suitable barns and sheds for the teams, implements and demands of the work.

8. General management, maintenance and equipment.

The statements here given as the parts of the whole proposition have been discussed in the foregoing details of this report, and hence need no further elaboration. The additional appropriation needed for the coming term of two years, in order to do the things necessary and essential to be done, is $10,890, by careful and conservative estimates. The separate items and the amounts needed are as follows:

Forest cultivation, 1,200 acres, at $3 per acre	$3,600 00
Preparation and planting of 400 acres of fields to seeds at $3.60 per acre	1,440 00
Cultivation of the 600 acres when fully planted in seeds for two seasons at $1.50 per acre per season	1,800 00
Road-building—main, lateral and fire lines	1,450 00
Construction of reservoirs	250 00
Border line fences	350 00
Building improvements	2,000 00

The grounds for these requests are the possibilities and the value of the institution to the welfare of the State, and its value

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as an investment. There is no longer a question raised as to the merits of the cause for which the institution stands, and there can be none raised as to the fitness of the institution and its value for the requests made for its advancement and completion. It, like any other State institution, could not be legislated into completeness at the beginning, but it was less possible in this case than many other of the State institutions because the location, the conditions, the needs and the possibilities were all unknown at the time the bill was formed for enactment into a law, and which was done by the General Assembly of 1903. Only a very conservative appropriation could have been proposed and accepted. The land conditions and the plan in the mind of the Board were the only definite elements known. After due consideration of several plans for maintenance and promotion of such an institution the Board decided on the plan as passed and the appropriation was placed at $3,000 annually, the mere approximated sum needed to manage, investigate and determine the rightful appropriations required and bring the same before the next General Assembly, and which are as above given. The Board respectfully urges the allowance of the same, to be equally divided between the two years intervening between the close of the two Assemblies, 1905 and 1907. Thus the annual appropriation, therefore, will amount to $8,445.

The institution as an investment alone will justify the appropriation for the improvement. The land values in the community of the Reservation have increased from two to three times since its establishment. This data is taken from the actual sales made within the past year, of which there were many, as compared with land sales before that time. The increment of the prime young forest with the increase of value with future time is an item of vast importance in considering the appropriations sought. The educational value for the cause of forestry to the people of the State by example and experiment is an element of consideration which can not be estimated in dollars and cents. The fact that it is State property justifies its being improved in a manner befitting the State. During the past year there were 911 visitors registered at the office of the Reservation. As the improvement is continued and the possible features developed the number of visitors will increase and the influence by direct contact will be much greater.

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A view of white pine growing on the knob lands of the Forest Reservation.

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REPORT OF WORK ACCOMPLISHED BY THE OFFICE.

THE MANIFESTED INTEREST IN THE SUBJECT OF FORESTRY BY THE PEOPLE OF THE STATE, AND RECOMMENDATIONS FOR FOREST PROMOTION.

The work accomplished in forestry by the office during the fiscal year was of the same character as that of the past few years; stimulating interest in forests, correspondence, forest inspections and recommendations and agitation by means of the public press, public gatherings and the mailing out of reports and bulletin publications bearing upon the subject. It is believed that all the efforts were fruitful of good results.

CORRESPONDENCE.

The correspondence of the past year was greater than that of any previous year in the matter of seeking forestry knowledge. The correspondents sought information of both a general and a special nature. The special inquiries indicated that a large number of individuals were devoting considerable attention to some special features of forestry, as the planting of trees suited for fencing posts, railroad cross-ties and similar uses, home tree planting for ornament and tree diseases. It also showed a considerable degree of interest in the work which was being done. The general inquiries were for literature giving a general knowledge of the subject of forestry, its purposes and opportunities, both as concerned the State and the National departments.

INSPECTIONS AND RECOMMENDATIONS.

The number of woodland inspections and recommendations made during the past year was not as large as last year, but the character of them were better in almost every detail. They possessed more of the elements of real forestry. There were thirty-eight personal inspections made by the Secretary and written recommendations rendered for woodland cultivation and pres-

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ervation. There were made by the Secretary five inspections for park and ornamental home plantings and the plots and recommendations rendered for the same. In addition there were recommendations made by letter for forty-eight post timber plantings for farm uses.

It must not be understood that the number of inspections here given constitute the extent of the work done in the State the past year. They simply indicate the extent of the work in which the Secretary was called on for assistance. A great amount of forestry work was done by individuals who followed their own ideas or else sought information for guidance in the forestry reports and bulletins mailed them.

The decrease in the number of inspections for the past year, compared with those of the previous year, is traceable to the forestry exemption law of 1899 and the completeness of the instructions contained in the literature mailed from the office.

The previous year was the one in which forest exemptions were to be filed without question as to the legal time or year it should be done, and many sought to take the advantages afforded by that act and thus sought aid in order to have the claims allowed. The impracticability of the law, however, has caused woodland owners to abandon it, and hence the falling off in the demands for the inspection of forests.

The reports and bulletins mailed from the office were complete in instructions for forest culture and tree-planting of almost every feature, and consequently afforded the information heretofore sought by the request for a personal visit, inspection and recommendation.

AGITATION.

The subject of forestry was aggressively discussed before the people by the methods of reports and bulletin publication, public addresses, and by visits into almost every community of the State.

The Bureau of Public Printing published for the office of Forestry 7,000 copies of the annual report of 1903 and for the office of Public Instruction 15,000 copies of the Arbor Day Annual. The former, to the extent of 5,000, were mailed directly from the Secretary's office to addresses supplied by the presidents of the county farmers' institutes throughout the State. The latter

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were expressed jointly by the offices of Forestry and Public Instruction to the county and city superintendents of schools, who in turn distributed them to teachers under their charges. By these means literature has been placed in the possession of the best citizens of every community. The remainder of the reports are being mailed daily as inquiry and requests are made for them.

The public press has been more than liberal with its columns in the publication of any matter pertaining to the subject, and great has been the influence for the good of the cause from this source.

The subject was also discussed before the county farmers' institutes, horticultural associations and literary and other club organizations by both local and assigned speakers. Personal visits were made into almost every community by the Secretary for the purpose of stimulating the cause and to determine the conditions and needs.

It has at all times been the decision of the Board that a thorough discussion of the subject before the people by every available means is the best way to promote the work. When the principles, the significance and the possibilities are instilled into the minds of the people, then the work of forestry will be advanced as it should be.

TREE PLANTING.

There are no statistics in hand to show the exact extent and kind of tree-planting done in the State the past year, but correspondence received from nursery firms indicate that it was greater than last year, and mostly of farm post timber trees and trees for ornament and shade around the homes and on lawns and public grounds. Nursery firms report that the demand and sale of such trees for Indiana exceeded the demands and sales for any other State, and that they could not supply the demands for seedlings of the former kinds of trees.

The indications, however, are that a splendid sentiment is forming favorable to the extensive culture of hardwoods for commercial purposes. It is only a question of sufficient time elapsing for the people to pass from the kindergarten features in which they are obtaining valuable experience to the larger work. It would be unreasonable to expect any other course from the people at this stage of forestry in this country.

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THE PROPOSITION.

The amendements which were passed by the General Assembly of 1903 to the original law which created this department were such that the office is enabled to perform creditable work and give it a foundation. The funds now provided the office, in conjunction with the Forest Reservation and Forestry Experimental Station, afford the means by which the Board can investigate and experiment and give to the citizens of the State something of facts. No additional funds for either salaries or office expenses will be asked. The present appropriations by frugal expenditures are ample for the present needs. The increased appropriations asked for the accomplishment of the work at the Forest Reservation and Experimental Station are absolutely necessary and minimum and should be allowed.

The law of 1899 for the encouragement of individual forestry should be repealed or else amended to meet the aims and justice of such a law. The Board feels that there should be a law enacted which will exempt any land which the owner agrees to devote exclusively to forestry purposes, under given instructions and a specified contract between the exemptor and the State Board of Forestry, and to continue for a period of not less than ten years from the date of the filing of the exemption and so long thereafter as the instructions and the contract shall be fulfilled. The exemption should be in the nature of a rebate from the regular tax payment equal in amount to the sum of the taxes assessed against such land appraisement.

The requirements for exemption should be a defined number or an average thereof of standard forest-growing trees per acre at all times during the continuation of the contract. The number or the average thereof of growing trees per acre should be governed by the conditions, as whether the area is at the time of exemption a forested or a nonforested area. There should also be a specific agreement as to the protection and cultivation such forest should receive. The sales of all timber from such exemption should be taxed at the cash value received. The work of inspection and report of such exemption as to the faithful compliance by the exemptor with the instructions and agreement to the county auditors on or before the first day of June of each year should be performed by the road supervisors in their respective districts

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at a stated fee per inspection and report, and any neglect or fraud on the part of the supervisors should be made an offense of misdemeanor and punishable by the existing laws for same.

Any violation on the part of the exemptor will be reported to the State Board of Forestry and the county auditor and the rebate of taxes discontinued by the county auditor until the decision of the Secretary of the State Board of Forestry that it shall be continued or discontinued, and such decision should be final.

Blanks for all applications for exemption, inspections and reports should be supplied by the State Board of Forestry so that uniformity of record could be easily kept.

A law of the nature here implied can be enacted legally, involving in its execution the Secretary of the State Board of Forestry, the county auditors and the road supervisors and of such simplicity of details that no difficulty will be encountered in its record. It will also prove a good impetus to the cause of individual forestry and will be just to all. The general effects of the same will justify its enactment, and such a bill will be formed and presented for enactment before the coming General Assembly.

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THE RELATIONS OF FORESTRY AND LUMBERMEN.

The forestry question, which is now being introduced and agitated in the most vigorous manner that it can under existing opportunities, should interest no class of industrial people more than the lumbermen. They must look to the forests as the source of lumber to carry on their business. In dealing with the subject of forestry in its relations to lumbermen I call attention to the following facts:

1. That the lumber business is a large, important and legitimate one.
2. That every improved and conservative method of using the timber in the mills will further the lumber industry.
3. That the present method of handling timber in the forest is very wasteful and destructive.
4. That the present method is opposed to continuous forest management on timber tracts.
5. That communities have interests in the perpetuity of forests and their conservative use.
6. That the timber conditions in Indiana and elsewhere demand a more rational method in handling the forests for lumber.
7. That the forest owners and lumbermen as a rule do not understand that it pays better to protect a good forest in harvesting the timber crop than to destroy it.
8. That a knowledge of how to handle a forest rightly is not generally known or, if known, is not regarded.
9. That community interests and lumber interests, as now conducted, are in dual relations.

These concessions are facts which will admit of no successful contradiction. The enormity of the lumber industry is evident from the following statistics for the United States: The annual consumption of wood in the United States is 25,000,000,000 cubic feet. Of this amount 40,000,000,000 square feet is made into board lumber; 500,000,000 cubic feet for railroad car construction, and a like amount for fencing material. It is estimated that the

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annual consumption of wood is 350 cubic feet per capita. As for Indiana, exact statements can not be given, but good reliable inferences may be drawn. Indiana a few years ago, according to the United States census, ranked fifth in the production of lumber. In 1898 the last partial statistics showed that 273,516,690 feet of lumber were sawed from the different varieties of timber in the State. I am told by lumbermen, in conversation, that the past year has been one of the largest in the lumber output, so that for Indiana the lumber business is still very great.

It is admitted, truthfully, that the improved methods of handling the timber, so far as sawing it with the least waste is concerned, leave little chance for improvement in most mills of any considerable capacity, but the great destruction and waste come in the handling of the timber in the forest. A visit to a tract of timber that has just been cut for lumber will show no signs of an attempt at economy in the saving of the young timber. It would be hard to find an example of more absolute destruction. The young growing timber is not regarded in felling the timber. It is cut and slashed for every conceivable convenience of handling the saw timber, both in cutting and handling. In many instances if the young timber had been carefully protected and let grow, in a very few years another good crop might have been harvested, as great or greater in value than the one removed. No attempt is made or even considered of continuing the tract in timber, and it is burned off and put into agriculture.

This absolute disregard for the right conversion of the timber and a failure to perceive that it would have paid better to have protected the forests in harvesting and continuing the forest tracts has brought us face to face with timber scarcity and damaged community interests of agriculture as well as that of lumbering. The lack of the knowledge of these things at a time when they might have been guarded has put community interests and lumbering in dual relation and forestry has for its purpose the arbitration of these interests.

Lumber dealers know more of the conditions of timber supply in Indiana than I. They as actual dealers know of its scarcity; but I am satisfied the following facts must be admitted:

1. That the large virgin poplar, walnut, ash, oak, and cherry no longer exist in abundance, to be purchased at any price in the hardwood district.

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A view showing a white oak pruning made in the autumn of 1903 and the healing advancement of one season.

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2. Trees are now anxiously bought at fancy prices which twenty years ago would not have been considered for fuel.

3. That regions abandoned as sawed up twenty years ago now have extensive mills and lumber traffic from the second crop to its almost complete exhaustion in the community.

4. That a large quantity of the finest hardwood timber is now imported in log form into the State and sawed or the lumber is imported.

5. That the greatest competition exists in every locality of timber supply outside the State as well as in it.

6. That so long as timber buyers have the cash and can offer enough they can buy except in very rare instances.

I do not care to submit any more of these facts for consideration. Lumber dealers may say truthfully that they have no trouble in getting all the timber they want; but the question is, How many years from now will they be able to get it? When every year sees vast areas of timber exhausted and put into agriculture and no attempt made to replant and cultivate, can it be possible that the end will never come? When less than 100 years has consumed 17,100,000 acres of the finest hardwood timber from our State, how long will the 1,500,000 acres left last? Prophecy based on past facts tells us that at the present rate, if no attempt is made at replenishment, the timber supply in the United States will last only sixty years. Such statements are not myths. In this country of progress, demand and consumption of every commodity are on the increase. Unless there is a change in the methods of timber dealings and an effort at replenishment made the timber supply must give out and the lumber business will be a thing only to be remembered.

It is for the prevention of the abuses of forests and the building up of right sentiments and inclinations that forestry was instituted. It is in these capacities that the relation of forestry to the lumbermen is found.

The law creating the Board of Forestry Department has defined the duties in a very general way. The duties stated as embodied in the law are: To collect, digest and classify information respecting forests, timber lands, forest preservation and timber culture, and to recommend plans for doing these things. The law further states that the Board shall recommend plans and methods for the

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A view showing a reckless case of pruning on a young poplar and the careless hacking with an ax in the hands of an individual employed who had no interest in the work except the wages he received.

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establishing of State forest reserves, and so far as practicable give out information on all the above phases of timber knowledge to associations and meetings of timber dealers, woodworkers, farmers and engineers of maintenance of way of railroads.

From the points of duty, as stated in the law governing the Board, the relation of forestry to lumbermen is a direct one. Timber promotion is the dominating element of duty. The things which should receive attention first, because of their relation to lumbermen, are the following:

1. Information should be collected and classified regarding the present forests so that people may know the real conditions in the State.

2. A rigid movement, legally, should be made to conserve and rightly use the present timber in the State.

3. An urgent movement should be made to perpetuate the present timber areas by cultivation and replanting, especially so in those parts of the State where the timber has become most exhausted.

4. The waste lands of the State should be planted in timber of the most valuable kinds suited to their soil and moisture adaptations.

5. The State should make wanton destruction of timber a misdemeanor punishable by law equal to the punishment meted out to offenders of our game and other natural resource laws.

6. Land-owners should be required by statute to keep and cultivate a fractional part of their estates in timber and to retain the same up to a given standard in numbers per acre.

7. The State should have legal powers in the hands of forest officers to enforce laws for the betterment of timber lands to rebound in their general effect to the State's welfare.

These suggestions may seem out of the question and unreasonable, but other nations of people who have in their past history been as lax as we in the conservation of their timber lands have been compelled for their general welfare to accomplish the things here mentioned and even by a much more extended and stricter policy than here outlined. They have also found it wise that they did so.

We as a State are now in the most prime condition to accomplish a great work in forestry which, if delayed, will mean much

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greater outlay, effort and time to accomplish. In the State are sufficient timber areas, if proper treatment is compelled, to insure the State against a timber famine for the future. The present forests are in shape to be cultivated easily because of the excellent stock of seeds and young trees they afford. Rightly used they will furnish a continuous supply of good timber to the lumber trade equal to the present output. But unless this is done a timber famine must come to us as it has come to others. It may be in the future beyond our vision of time, but it must and will come unless a change takes place.

I think I may sum up the whole relation of forestry to lumbermen in the following statements, which outline the policy to be followed by the department in its work:

1. To promote in the best way the present timber lands in the State by insisting that they be conserved, cultivated and used in the right way.

2. To promote the planting of the waste lands in the State to timber of the most valuable commercial kinds suited to them in their soil and moisture conditions.

3. To have landowners plant and cultivate new forest areas for economic uses as an auxiliary to the saving of the present timber areas.

4. To recommend and induce such legislation as will insure a better respect for timber and timber promotion throughout the State.

5. To stand as a bureau of information in the best sense for all the phases of such, as is set forth in the law creating the Board.

In the doing of these duties it asks the united support of the Indiana lumbermen and every other intelligent organization in the State.

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THE FARM WOODLOT—ITS PERPETUATION AND CAUTION IN TIMBER SELLING AND CUTTING.

The farm woodlot is properly receiving the earnest consideration of foresters at this time. As stated in foregoing articles, the commercial and extensive forest cultivation will be confined to the poor lands in the State which are unfit for annual crops and raising of stock. Such forestry will also be carried on largely by individuals and corporations who have sufficient means to successfully project and mature a long-lived industry, the returns from which are distant and cumulative. But a farm woodlot should be retained on every farm. It is not the intention to state the proportion of the farm which should be devoted to forest cultivation. At this time even a suggestion would be vague and indefinite. Forestry knowledge is too meager at this stage of propagation.

A vast majority of the farms of any extent in this State, outside of those in the prairie sections, possess more or less timber area, which is being retained as the woodlot portion. A casual observation of these farms disclose the fact that the greater proportion thereof is anything but valuable in timber resources. They possess but a limited variety of trees, and they are of the least valuable qualities. The whole consists of a jungle of tops, logs, wild briers, thorn, hazel and worthless underbrush. They may decently be called fragments. They are almost valueless for lumber use, likewise for fencing material. Their only value is in fuel and scanty pasture. Instead of being reckoned as values in farm sales, they are regarded as being worthless, and detrimentally affect the estimate of the entire farm.

Such woodlots do not pay for retention, and therefore should not be maintained. If a farmer has ten or twenty acres of such area, he should devote one-half of it exclusively to forest cultivation and the other half to pasture and agricultural purposes. The half retained, regenerated and cultivated in timber, according to the plan given below, will not only produce more and better tim-

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A view of a chestnut oak pruning made in the autumn of 1903, showing the splendid healing effects of one season.

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ber in after years, but will lend an æsthetic and systematic appearance to the farm, will provide an interesting and agreeable occupation to the owner, and be a valuable adjunct to the farm.

The time is at hand when a good growing timber area on a farm will greatly enhance the value of the land, the same as good fences, buildings and drainage. For some time past farmers have realized the scarcity of timber and the imperative necessity for conserving a portion of their woodland. To this end they have fenced off a portion that it might renew itself naturally with trees. Under favorable conditions as regards seed trees, shelter and humus soil such a plan will be fruitful of fairly good returns, but by securing the proper shelter, light, soil conditions and seeds, and by grubbing out the worthless kinds which usually spring up and choke out the valuable growth, the likelihood of gratifying and profitable results will be greatly augumented.

By following the method of timber cultivation and perpetuation prescribed a vast saving in area and in increase of product in both quantity and quality will result to the farmer, and the area retained will be a forest in the full meaning of the term. If the regeneration is unaided by systematic sylviculture the results will be tardy and the quality deficient. The process employed should be a combination of the natural and artificial methods. There are various systems proposed for regenerating such areas of forest as have been described. I am more favorable to the "strip" and "group" methods than to any of the others. I am confident that they more generally meet the conditions existing within the State. Under the "strip" system the regenerative process is conducted over strips instead of over the whole area to be cultivated.

The strips are treated so as to have three receiving attention at the same time; one being in the completed stage, one in the stage of seeding, and one in the stage of preparation. The breadth of the strips is determined by the influences under which the owner is acting. The operations should be begun on the most permanent side and extended one after another until the whole tract is treated. In this manner the work will be better done and different stages of timber will be growing.

The "group" system may be viewed as a modification of the "strip" plan. Under its working different patches are regenerated at intervals over the forest area, and these are then enlarged by

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View of a chestnut pruning made in the early spring. Sap flowed excessively from the cut, insects and borers gathered therein and thus produced the scabby affects and damages to the wood.

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A view showing a bad case of hickory pruning made in the early spring. The bark checked loose from the wood, the limbs were severed out from the trunk, the wood split and the bark torn and peeled away.

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the same three stages of operation till they converge and the whole area is thus regenerated. The main objection to this system is the unevenness of forest it produces. It is only a convenient means when good seed trees exist to spread out from them. In almost every forest some good trees are left standing which may be made nuclei for regenerating. It is a good plan where the varieties are desired in groups as opposed to a general mixture.

Many considerations, which should be carefully weighed, enter into these regenerating processes. The porosity, moistness and soil humus are factors which the soil itself must possess in right relations. The climate and denseness desired are other important features. It may require much artificial assistance to get these relations in accord. In case where there is too much humus and rubbish the same must be removed before the seed is sown. If the humus is deficient the soil will have to be worked by such means as hoeing, plowing or harrowing. In cases of sod the same course must be pursued. If too much shelter exists the timber should be removed until the proper shelter and light are secured. Good conditions exist when enough shelter is obtained to prevent weed and sod growth, and the soil is seen in half mixture with humus. When such conditions prevail the seed will sink readily into the soil, and the roots of the germinating seeds can penetrate for sustenance.

If these plans are followed, and good seeds are planted, the woodlot will be all that is desired and demanded and the whole country will be more valuable and beautiful.

In the retention of these woodlots, and that they may be easily perpetuated, there should be more care exercised in the matter of selling and cutting the crop when trees become ready for the market. Woodlot owners sometimes sell to a timber dealer all the saw timber on the entire tract, never thinking what may constitute saw timber in the estimation of the buyer. In this age of scanty timber supply anything that will square a four by four inch studding or make a box board is considered saw timber, and consequently a misunderstanding arises between the owner and the buyer. The owner finds his woodlot fairly denuded of any standing trees large enough for fencing posts after the buyer is through with his work. If the owner anticipated permitting the area to remain and grow up again for another crop he finds himself dis-

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appointed because the cutting has been so complete that scarcely nothing remains, and the universal condition is that what does remain has been so badly damaged by the obtaining of the other trees that the result is he burns the tract off and devotes it to agriculture.

When timber is sold under such a contract the owner should stipulate the limit in the size of the trees to be cut and also require under contract the care against damaging the trees which are to be retained. Under such caution the permanency of the woodlot can be secured and the benefits to owners very much increased.

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A view of a 30-year old catalpa planting by the E. & T. H. Railroad near Sullivan, Indiana. This planting was fire burned every year since planting, was not cut back to induce sprout growth and was planted on hard retentive red clay soil. The strip is a mile long and about 10 rods wide. It is all that could be expected under the conditions.

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BLACK LOCUST PLANTING OF HON. Q. A. MYERS, LOGANSPORT, IND.

Mr. Myers has a black locust grove of 15,500 trees, which he planted for post purposes. On one division of his land was a sandy ridge, which washed badly, and was too loose for successful farming in crops. The land was crossed off, at distances of three feet eight inches each way, without even plowing the ground. With sharpened fork handles placed in the hands of boys holes were made in the checks by jabbing the handles into the ground for the planting of the trees. The seedlings planted were of one year's growth, and assorted to sizes of from twelve to fifteen inches high. At these sizes they possessed but one straight root, and, consequently, the planting was speedily performed. The trees were planted a year ago last May, so at present they are just in the middle of the second season's growth, but they will easily average ten feet in height.

The success of this planting is better understood when it is considered that the trees have never had any cultivation. They were simply left to themselves after being planted. It would have been better, perhaps, had they been plowed and trimmed during the first season or last spring, but the grove shows that the planting will be a great success without any care.

The expense of this grove was very small. The entire cost of labor to date is but $10.50. The cost of the seedlings, which were secured from an Illinois nursery firm, was $1.70 a thousand, making the total cost to date $36.85. Unless some unexpected calamity befalls this locust forest, Mr. Myers estimates that he can begin harvesting posts in about six or eight years, and by the end of twelve years he can cut a full crop of an average of at least two posts a tree. The financial results of the grove seem assured at the present price of posts, or even at much less.

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CATALPA PLANTING BY SENATOR JOHN W. PARKS, PLYMOUTH, IND.

In the spring of 1902 Senator Parks secured from R. Douglas & Sons, Waukegan, Ill., 5,000 young catalpa seedlings from eighteen to twenty-four inches high, at a cost of $2.50 per thousand. In the spring of 1903 he secured from D. S. Lake, Shenandoah, Iowa, 10,000 of the same size and at the same cost, and this spring 2,500 more were purchased from the same firm. All of these trees were planted on his farm adjoining the city limits of Bourbon, Marshall County, Ind. The land selected was good, sandy, loose soil of fields which have been under good cultivation for many years, and is valued at from $100 to $125 per acre.

In May of each spring the ground was broken and prepared for planting in the same manner as for corn planting. The distances apart at which the trees were planted are five feet each way. The task of planting was easy and was personally supervised by the Senator. Each planter was supplied with a bucket containing trees and a spade with which to make the excavations and perform the planting. The buckets contained a slush of water and clay in which the roots of the trees were kept imbedded until removed at planting. The roots of the seedlings were not permitted at any time to become dry. Every detail of the work was carefully executed, and so successfully has it all proven that scarcely a tree is missing.

The cultivation since planting was very simple and inexpensive. The trees were plowed two or three times during the season and the weeds cut out. The first planting was cut back to the ground this last March to permit sprout growth for the future permanent trees. Senator Parks, like many others, was slow to consent to this treatment of his trees. He felt that it was throwing away all of the growth which the trees had made and the time spent in their cultivation, but results have convinced him of the wiseness of such a method.

The trees from the time of planting grew rapidly, but owing

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to the nature of the catalpa to bush, little promise was shown of a good bole formation. They were small, spreading trees. The result of the sprouting from the cutting back is all that could be desired. Scarcely a stump failed to sprout. The only fault that could be found was the profusion of sprouts, owing to the fact that the trees were cut back in the season of vigorous sap flow instead of the season of dormant sap. In this particular the Senator was reluctant to obey orders, fearing that the stumps would fail to sprout if the cutting back were performed in the fall of the year. By this latter observance he would have avoided the profusion of sprouts.

In addition to the extensive growth is added the fine, straight, tapering boles giving every promise of relief from the natural stubby, branching proclivities of the tree. The average of the growth for the field is nearly five feet for the brief time.

The second planting shown in the photograph was cut back this fall for sprouting. It is better to allow at least three years' of root growth to form before cutting back, as the extensiveness of the same will add much to increase the successful sprouting in every way. The performance of this feature of the cultivation did not present any difficult work. A large pruning shear was the only implement necessary in the hands of a man to clip off the trees close to the ground as fast as he could walk to them. If the shear is kept sharp and the operator is apt, the cutting can be done quickly without splitting the stump or tearing the bark from it. The stumps were cut smooth and uninjured by tearing off the bark or splitting the wood, and thus the good results were obtained. The removal of the brush was a small task.

The work of selecting the sprout to form the permanent tree and the cutting away of the others required more work and caution than any other feature of the cultivation. A sharp knife blade was all the instrument needed in this work. The strongest, best sprout was selected to remain and all the remaining ones carefully cut away. At no time should they be torn off by the hand, as such process will split the bark from the stump and thus destroy the growing strength of it.

The same method of treatment will be given each planting when the proper time comes, and then the plantings will be allowed to grow unmolested to maturity for the purposes intended, which pur-

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poses, by the Senator, are railroad ties and fencing posts. The chief attention that will need to be given them after one year from cutting back is a little attention to keep extra sprouting down and to protect the trees from outside harm of fires, stock and any other destructive agents.

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THE RELATION OF FORESTS TO STREAM FLOW

By James W. Toumey, Collaborator, Bureau of Forestry.

INTRODUCTION.

For the purposes of the present discussion "forest" must be understood to mean a growth of trees sufficiently dense to form a fairly unbroken canopy of tops, not a scattered growth of low, round-headed trees with bushes and herbage constituting the dominant types of vegetation.

Forests of this kind do not occur in the United States where the mean annual precipitation falls below eighteen to twenty inches, except on restricted areas where unusual conditions prevail. The line of separation between the great eastern forest area and the plains approximately coincides with a north and south line marking a mean annual rainfall of twenty inches. The streams which rise in the Rocky Mountains and flow eastward are bordered by forests for long distances into the plains, where the annual rainfall is much less than twenty inches. These forests, however, are not so much a result of the rainfall in the regions where they occur as of surface and seepage flow from adjacent regions. The mesquite forests of the desert regions of Southern Arizona, where the mean annual rainfall is but eight to twelve inches, are made possible by the seepage and surface waters from the adjacent mountains.

The question of the exact relation which exists between forests and stream flow has long been under discussion. The broad fact that a relation exists is indeed indisputable. Forest destruction always produces a change in the character of the run-off. But the scientific determination of all the causes which produce this effect, and of their relative importance is a difficult and complicated matter. In spite of the fact that for many years European forest experiment stations have been carrying on observations, measurements, and experiments designed to clear up this subject, final conclusions covering the whole field have not yet been established. In this country almost nothing has ever been done to secure accurate

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data for the investigation of this problem as a whole. Some light, however, has been thrown on the subject by means of a series of observations which have been going on for several years in the San Bernardino Mountains in Southern California. It is the purpose of the present article to make clear what are the various factors entering into the problem, and to state some of the more important facts that these observations in Southern California reveal.

In the San Bernardino Mountains records of precipitation for several years, at a large number of stations, shows that differences in forest cover are closely correlated with differences in rainfall. This correlation is so close that it is possible to judge the mean annual precipitation with a fair degree of accuracy from the appearance of the forest alone. In these mountains forests cover the slopes wherever the mean annual rainfall exceeds twenty to twenty-four inches; however, on southern and western slopes forests of equal density represent a larger rainfall than on northern and eastern slopes.

Other things being equal, regions having the greatest rainfall bear forests of the greatest density and luxuriancy of growth; but where the mean annual rainfall falls below eighteen to twenty inches, types of vegetation in which trees predominate are replaced by those in which shrubs and herbage predominate.

WHAT CAUSES RAINFALL.

Because rainfall is most abundant where forests grow, many believe that forests exert an important influence on the amount of precipitation. A more reasonable inference, however, is that rainfall is the great factor in controlling the distribution and density of forests.

Precipitation occurs whenever the air is suddenly cooled below the dew-point. The most effective cause of this is the expansion of air on ascending. The upward movement is caused very largely by cyclonic storms.

Whether forests have any appreciable effect in cooling the air to below the dew-point is uncertain. From the known effect of forests on the temperature and relative humidity of the air, it is reasonable to infer that they may have some such effect, at least to a small degree, and consequently that they may have some influence in increasing precipitation. The present evidence, however,

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derived from many series of observations conducted in Europe and elsewhere, is so conflicting that a definite answer to this question, having the stamp of scientific accuracy, is not possible.

WHAT BECOMES OF THE RAINFALL.

That the excessive destruction of forests is followed by the drying up of streams and springs and by a diminution in the minimum flow of rivers is a well-established fact. The forest is the most effective agent known in regulating the disposition of the precipitation after it reaches the ground.

Rainfall escapes from the ground upon which it falls in five ways —through evaporation, transpiration, surface run-off, seepage run-off, and deep seepage. By evaporation is meant the moisture which passes into the atmosphere in the form of vapor from water and soil surfaces and from objects resting upon such surfaces, including vegetation. Transpiration is that portion of the rainfall which sinks into the soil, and which is later taken up by the vegetation through the roots and given off to the atmosphere through the stems and foliage. To this latter should be added, although not actually a part of it, the comparatively small amount of moisture taken up by the vegetation, but which through chemical change becomes a part of the organic vegetable structure. By surface or superficial run-off is meant that portion of the precipitation which, from the time of falling until its exit from the drainage basin, passes over the surface without gaining access to the soil. On the other hand, by seepage run-off is meant that portion of the rainfall which sinks into the earth, but which later reappears on the surface at lower elevations, and with the surface run-off escapes from the drainage basin in the streams. By deep seepage is meant that portion of the precipitation which sinks into the soil, but to such depths that it does not reappear later on the surface of the drainage basin.

Evaporation and transpiration are frequently classed together as evaporation. In the irrigated parts of the West they are together known as "fly-off." So, also, the rainfall which does not escape through evaporation and transpiration or through deep seepage is often classed as run-off or stream flow.

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DO FORESTS INFLUENCE EVAPORATION?

In order that the moisture which falls to the earth in the form of rain and snow should be most efficient in sustaining vegetation and in feeding streams, as little as possible should escape in the form of evaporation. Under the best of conditions a very large part of the annual rainfall is returned to the atmosphere through evaporation. For humid regions, bearing the same types of vegetation, the amount does not vary much from year to year, no matter what the fluctuations in rainfall are—a fact first made known by Messrs. Lawes, Gilbert, and Barrington in the classical Rothamsted investigations. These gentlemen explain this persistency in the rate of evaporation by the fact that heat and abundant rain seldom occur at the same time. Consequently, in a wet season, the lower temperature and more or less saturated atmosphere prevent excessive evaporation; while in a dry season, although the temperature is higher and the air drier, there is less water to evaporate, and the two extreme conditions balance each other so far as the amount of evaporation is considered. This is not true, however, in arid and subarid regions, because during years of minimum rainfall the upper layers of the soil are often so dry for months at a time that there is very litle moisture to evaporate, while on the other hand during years of maximum precipitation the atmosphere is not sufficiently saturated to check rapid evaporation.

There is little or no difference between evaporation from a water surface and from any other surface that is thoroughly wet, when both are exposed to the same atmospheric conditions. The evaporation from a water surface is, however, always the same under the same conditions, but it is not the same from other surfaces, because they vary from completely wet to completely dry.

In the forest the crowns of the trees remain wet but a short time after precipitation. During this period, however, the evaporation is undoubtedly very rapid, on account of the large surface and from the fact that the crowns are exposed to the wind and the sun. But in a long series of investigations made at the Forest Experiment Station at Nancy, France, and recently published, it was found that a deciduous forest near that station held back from the ground less than 8 per cent. of the total precipitation. Although this is almost immediately returned to the atmosphere in the form of evaporation, it is a comparatively small amount of the annual rainfall. On

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the other hand, evaporation from the soil in the open and in the forest continues often for long periods after the precipitation ceases. After the crowns become dry, evaporation is much retarded in the forest, because the forest floor is protected from the wind and sun. To such an extent is this true that the loss of moisture through evaporation is much less than that lost from an equally saturated soil or from a water surface in the open. Repeated European observations, extending over long periods of time, and shorter observations made in this country, conclusively show that evaporation from water or other wet surfaces on the floor of the forest is but one-third or one-fourth that from similar surfaces in the open. From the investigation of the moisture content of soils in the San Bernardino Mountains, the results of which are as yet unpublished, it appears that the first foot in depth of the mineral soil in the forest may contain two or three times as much moisture as soil of the same general character from similar situations in the open.

During the summer it is impossible to determine by actual measurement the loss of water from the soil either in the forest or in the open, because conditions as to moisture content constantly vary. During the winter, however, the evaporation from a snow surface can be measured with a fair degree of accuracy. Measurements made in the San Bernardino Mountains show that evaporation from snow surfaces may be four or five times as great as from water surfaces under similar exposure, and also that the rate of snow evaporation is profoundly influenced by the wind. In our Western mountains, where the snows are exposed to dry winds, the loss through evaporation is a large percentage of the total snowfall. In the San Bernardino Mountains, snowfalls a foot in depth are sometimes evaporated in two or three days without even moistening the soil. In so far as forests check the winter winds and provide shade, they lessen winter evaporation. This lessening of the evaporation from snow surfaces, through the action of forests, is seen in the fact that snows linger much later in spring in well-wooded regions than in open areas. It appears, then, that forests materially retard evaporation, both of soil moisture and of snowfall.

DO FORESTS INFLUENCE TRANSPIRATION?

When land is covered with vegetation a certain amount of the rainfall is taken up by the growing plants. A small part, through

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chemical change, becomes incorporated into the plant, but the larger part is returned to the atmosphere through transpiration. Although those who have investigated this subject are by no means in accord, there is reason to believe that considerable difference exists in the amount of water taken up by the different types of vegetation in the process of growth. On the whole, the forest probably takes up less water from the soil than the average agricultural crop. Risler, from a lengthy series of investigations, reached the conclusion that forests actually take up less than one-half as much water from the soil as the average agricultural crop.

The above would lead one to infer that where the soil, if not covered with forest growth, is clothed with grass or some other low form of vegetation, the return of moisture to the atmosphere, through evaporation and transpiration, or, in other words, the "fly-off," is less from the forest than from the open. But in regions having a short wet season followed by a long dry one the return of moisture to the atmosphere is probably greater from a forested area, because in the open for a large part of the year there is very little to evaporate, and the scanty growth of grass and other low forms of vegetation gives little opportunity for loss through transpiration.

THE INFLUENCE OF FORESTS IN REGULATING THE RUN-OFF.

Stream flow consists of both surface run-off and seepage run-off. Although these two can not be separately determined, total run-off admits of accurate measurement. Surface run-off may be considered as flood water, while seepage run-off is that portion of the drainage which gives the streams a sustained flow. It is evident that any factor which decreases the surface or superficial run-off and increases the seepage run-off is of the utmost importance in regulating the flow of streams.

The proportion of flood water to seepage is influenced by the rapidity of the rainfall. It is well known from direct observation that a slowly falling, prolonged rain, even on the naked soil of steep slopes, is all taken up by the soil. On the other hand, a heavy shower of short duration, falling on the same slope, may largely escape as run-off. In the first instance each drop has time to be absorbed by the soil, while in the latter the accumulation of drops is more rapid than the absorption, and the excess moves over the

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surface to lower elevations. The forest canopy very perceptibly extends the period of time during which the rain reaches the soil, and in this way lessens surface run-off.

Again, forests, by checking the velocity of the wind and covering the mineral soil with a thick layer of dead leaves and other forest litter, effectively prevent soil transportation by both wind and water. On high elevations, where streams generally have their birth, the influence of the forest in this respect is of the utmost importance. So great is this influence that it exerts a marked effect upon topography. In mountainous regions particularly, the repeated destruction of forests permits the soil formed by the decomposition of the rocks at the sources of streams to be transported to lower elevations, with a consequent slow change in the details of the landscape. Such regions, if unforested, are apt to have precipitous slopes and scanty soil on the higher elevations. In that case there is no adequate medium to absorb the rain, and it flows over the surface. On the other hand, if such regions are well wooded, the slopes are less precipitous, and a considerable depth of soil usually covers the broad summits. As a result, the rain water is absorbed and the surface flow is reduced to a minimum.

Not only is it essential to have an adequate medium present to absorb the rain, but it must be of such character as to absorb quickly. The rapidity with which rain is absorbed is very largely governed by the physical properties of the soil, the organic litter upon it, and the vegetation. Decayed organic matter, by itself or in combination with mineral soil, absorbs moisture much more rapidly than soil containing little or no organic matter; hence, the greater the amount of leaf mold and other litter, the more rapidly will the rain be absorbed. Rapidity of absorption is also influenced by the degree of looseness of the mineral soil. In the forest the mulch of leaves and litter keeps the mineral soil loose and in the best condition for rapid absorption.

Not all the rain that is not absorbed by the soil where it falls reaches the stream by flowing over the surface. Much of it is taken up in passing from the place of falling to the stream. The amount taken up depends upon the obstructions in its pathway. Where there are no obstacles, as on barren ground, the moving water, by eroding channels, forms small rivulets, and these larger and larger ones, which flow with constantly increasing velocity. As a result,

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the water passes rapidly over the surface, and but little gets into the soil. When the soil is covered with obstructions, such as are offered by a forest with its accumulation of litter and vegetable growth, the rain which is not immediately absorbed is checked in its flow over the surface. The water, being held back, is finally taken up by the soil and thus prevented from forming small rivulets through erosive action.

The forest, in extending the time during which the rain reaches the soil, in its effect upon local topography, and in supplying a larger and better absorbing medium, must necessarily have a profound influence in increasing the seepage run-off, and in proportionately decreasing the surface flow.

COMPARISON OF RUN-OFF FROM FORESTED AND NONFORESTED AREAS.

There are so many complex conditions influencing the flow of streams that it is extremely difficult to determine the effect of forests on run-off by the comparison of the discharge of streams on forested and nonforested catchment areas. It is believed by many that stream flow is so largely influenced by the amount, intensity and character of the precipitation, the configuration and area of the catchment basin, the character of the absorbing medium and the underlying rocks, and the general climate, as well as the forest itself, that we shall probably never be able to measure quantitatively the influence of forests on the flow of streams by the comparison of forested and nonforested regions. Catchment areas differ so greatly in the features mentioned above that our most conservative and able investigators have been forced to the conclusion that "in respect to run-off, each stream is a law unto itself." Although the above is probably in the main true, yet, by the careful selection of small catchment basins for comparison, it appears that the influence of the forest in diminishing the surface run-off can be determined with a fair degree of accuracy. When the catchment areas compared are in the same region, are influenced by the same or nearly the same climate and precipitation and by the same storms, have approximately the same configuration and area, and have a similar mineral soil and underlying rocks, the effect of these various factors on the run-off can be ignored, and the differences in the behavior of the stream flow on the forested and nonforested areas

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can be assigned to the influence of the forest.

In a careful study of the behavior of the stream flow on several small catchment areas in the San Bernardino Mountains, it has been found that the effect of the forest in decreasing surface flow on small catchment basins is enormous, as shown in the following tables, where three well-timbered areas are compared with a non-timbered one:

Precipitation and run-off during December, 1899.

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Sq. miles.		*Inches.*	*Acre-feet.*	*Per cent.*
0.70	Forested.....	19+	36–	3
1.05	.....do	19+	73+	6
1.47	.....do	19+	70–	6
.53	Nonforested.....	13–	312+	40

At the beginning of the rainy season, in early December, the soil on all four of these basins was very dry as a result of the long dry season. The accumulation of litter, duff, humus, and soil on the forest-covered catchment areas absorbed 95 per cent. of the unusually large precipitation. On the nonforested area only 60 per cent. of the precipitation was absorbed, although the rainfall was much less.

Rainfall and run-off during January, February, and March, 1900.

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Sq. miles.		*Inches.*	*Acre-feet.*	*Per cent.*
0.70	Forested.....	24	452+	35
1.05	.....do	24	428+	33
1.47	.....do	24	557+	43
.53	Nonforested.....	16	828+	95

The most striking feature of this table as compared with the previous one is the uniformly large run-off as compared with the rainfall. This clearly shows the enormous amount of water taken up by a dry soil, either forested or nonforested, as compared with one already nearly filed to saturation. During the three months here noted, on the forested basins about three-eighths of the rainfall appeared in the run-off, while on the nonforested area nineteen-twentieths appeared in the run-off.

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Rapidity of decrease in run-off after the close of the rainy season.

Area of catchment basin.	Condition as to cover.	Precipitation.	April run-off per square mile.	May run-off per square mile.	June run-off per square mile.
Sq. miles.		*Inches.*	*Acre-feet.*	*Acre-feet.*	*Acre-feet.*
0.70	Forested.....	1.6	153–	66–	25–
1.05	.....do.....	1.6	146–	70+	30–
1.47	.....do.....	1.6	166+	74+	30+
.53	Nonforested.....	1	56+	2–	0

The above table clearly shows the importance of forests in sustaining the flow of mountain streams. The three forested catchment areas, which, during December, experienced a run-off of but 5 per cent. of the heavy precipitation for that month, and which during January, February, and March of the following year had a run-off of approximately 37 per cent. of the total precipitation, experienced a well-sustained stream flow three months after the close of the rainy season. The nonforested catchment area, which, during December, experienced a run-off of 40 per cent. of the rainfall, and which during the three following months had a run-off of 95 per cent. of the precipitation, experienced a run-off in April (per square mile) of less than one-third of that from the forested catchment areas, and in June the flow from the nonforested area had ceased altogether.

DO FORESTS INCREASE THE RUN-OFF?

Owing to the very complex nature of the investigation involved in determining the effect of forests on the amount of run-off, the available evidence does not admit a definite answer that will be of general application. It is reasonably certain from present evidence that in some regions the effect of the forest is materially to increase the run-off. It appears equally certain, however, that on other regions, and on certain classes of catchment areas, the effect of the forest is to materially decrease the stream flow.

Mr. Rafter, in his recent publication, "Relation of rainfall to run-off," makes this statement: "With similar rainfalls, two streams, one in a region having dense primeval forests, the other in a region wholly or partially deforested, will show different run-off. The one with the dense forest will show a larger run-off than the stream in the deforested area." This author concludes, from

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the careful study of a large number of catchment areas in the State of New York, that the effect of the forest on at least a portion of the area studied is to increase the run-off to an amount equal to from 5 to 6 inches in depth over the entire catchment area.

In humid regions, where the precipitation is fairly evenly distributed over the year, and where the catchment area is sufficiently large to permit the greater part of the seepage to enter the stream above the point where it is gauged, the evidence accumulated to date indicates that stream flow is materially increased by the presence of forests.

In regions characterized by a short wet season and a long dry one, as in southern California and many other portions of the West, present evidence indicates, at least on small mountainous catchment areas, that the forest very materially decreases the total amount of run-off.

Annual rainfall and run-off on forested and nonforested catchment areas in the San Bernardino Mountains, California.

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
Sq. miles.		*Inches.*	*Acre-feet.*	*Per cent.*
0.70	Forested.....	46	731	28
1.05	.....do.....	46	756	30
1.47	.....do.....	46	904	36
.53	Nonforested.....	33	1,192	69

On small nonforested catchment areas in the West, and possibly on large ones as well, a very large part of the heavy precipitation of the rainy season flows over the surface, quickly reaches the stream, and is discharged from the catchment area as flood water, much as water escapes from the roof of a building. On such areas the actual loss through evaporation during the dry season is probably far less than from a well-wooded area, because the surface soil and streams are dry and there is very little moisture left to evaporate. On such denuded areas it appears that the run-off for the few months that the stream flow is considerably larger than that for the entire year from similar forested areas. Although a nonforested area may, in certain instances, produce a larger run-off than a forested one, this probably never occurs except when the run-off from the nonforested area is largely flood water, and of destructive rather than constructive significance.

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CONCLUSION.

In conclusion it may be said that although the forest may have, on the whole, but little appreciable effect in increasing the rainfall and the annual run-off, its economic importance in regulating the flow of streams is beyond computation. The great indirect value of the forest is the effect which it has in preventing wind and water erosion, thus allowing the soil on hills and mountains to remain where it is formed and in other ways providing an adequate absorbing medium at the sources of the water-courses of the country. It is the amount of water that passes into the soil, not the amount of rainfall, that makes a region garden or desert.

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RECENT PROGRESS IN TIMBER PRESERVATION

By Hermann von Schrenk, in charge of Forest Products, Bureau of Forestry.

INTRODUCTION.

During the past year interest in the subject of timber preservation has grown throughout the United States. At the present time there are no less than six large preserving plants under construction or under consideration. The increasing difficulty experienced in getting high-grade timbers, as well as the increasing prices of such timbers, has brought the question of the preservation of woods of lesser resisting powers to the front. In the past the long-lived timbers, like white oak, longleaf pine, and cedar were employed whenever resistance to decay was an important requisite. As long as these timbers were available in large quantities, it proved most economical to use them. Now that they are much more difficult to get, and consequently more expensive, the question is frequently asked: Is it practicable to use timbers which are not as resistant to decay, but which can be treated chemically; and, if so, what does it cost to treat them, and what length of life is it possible to get?

It is a matter of great importance to all users of timber to know (1) what timbers they can use; (2) how large the supply is; and, (3) how the poorer timbers, when once they are available, can be made more or less decay proof. This subject will therefore be considered from these three standpoints.

TIMBERS WHICH CAN BE TREATED.

Of the inferior timbers, that is, timbers of less decay-resisting powers, which it will probably pay to treat in one way or another, the following is a provisional list:

Some timber trees susceptible of preservative treatment.

Northern and Eastern United States.—Maple, beech, birch, hemlock, loblolly pine, red oak family, North Carolina pine.

Central United States.—Red and swamp oaks, beech, hemlock, tamarack, gum, loblolly pine, cottonwood.

Western United States.—Tamarack, lodgepole pine, red fir, hemlock, yellow pines, true firs.

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These timbers are, as a rule, somewhat porous, and consequently, when properly prepared, will allow of a more or less complete penetration of a preservative solution. A large number of them grow with great rapidity and are therefore desirable trees to encourage in any plan involving forest management. Success in the use of any or all of the so-called inferior woods will depend almost entirely on the manner in which they are handled. It is absolutely safe to say today that, with proper preliminary preparation and proper treatment with a preservative, any and all of the timbers referred to above can be made to withstand decay for longer or shorter periods, depending upon the kinds of preservatives used.

Attention should be called to the statement that these timbers "will withstand decay." Preservative treatment will not protect

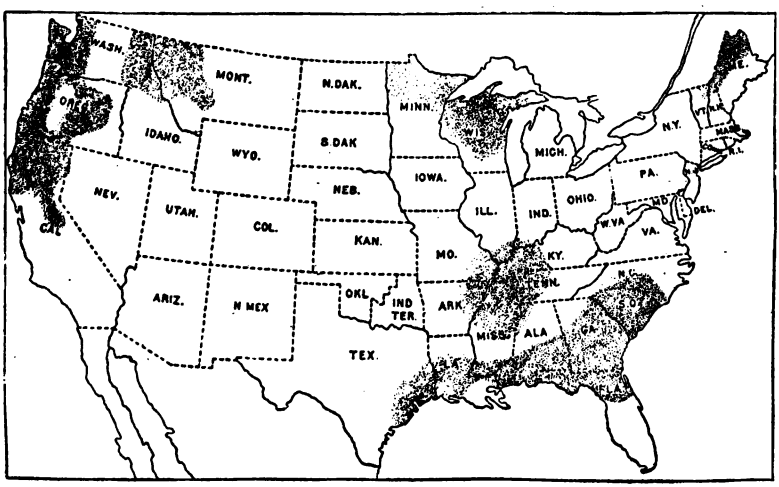

FIG 16.—Distribution of large sources of timber supply.

a timber against mechanical abrasion. Red oak or loblolly pine treated with creosote will last indefinitely in the form of a fence post or telegraph pole, but both these timbers will wear out in the form of a railroad tie after a short period unless devices to protect their fibers are adopted. In other words, preservative treatment, as we know it today, protects against decay but not against mechanical abrasion.

SUPPLY OF INFERIOR TIMBERS AVAILABLE.

An important consideration which will determine to a large extent whether timber preservation will be practiced, relates to the probable supply of such timbers. While it is not possible to give

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accurate figures as to the supply of any one timber, it is possible to point out in a general way where the great centers of forest wealth are. A glance at the map (fig. 46) will show this. In the New England States we can count on considerable quantities of birch, balsam fir, and maple. In the central Mississippi Valley there are large quantities of inferior oaks, beech, and gum. In the South the inferior pines have hardly been touched, while in Wisconsin and Minnesota the tamarack and hemlock are available in large quantities. In the Northwestern States, hemlock, red fir, tamarack, and true firs are found in great abundance. It appears therefore that there are still at hand large supplies of the inferior timbers, and that the centers of supply are widely distributed over the country.

Having found which timbers can be used, it becomes necessary to determine what will constitute a proper preparation for treatment.

HOW TO PREPARE INFERIOR WOODS FOR TREATMENT.

The object of a preliminary preparation for treatment is to make the wood as porous as possible. Most of the woods classed as inferior are more or less open grained, and for this reason are far better suited to preservative treatment than the high-grade timbers, which are denser. Freshly cut wood is full of water, contained largely in cell walls of the wood fiber. In addition to water the wood fibers of the sapwood contain certain small quantities of starches, sugars, albuminous substances, etc. Without going into details (discussed in full in Bulletin No. 41, Bureau of Forestry), it may be said that wood in which these substances are present is rendered less permeable by their presence, that is, most preservatives will not penetrate wood which is wet and full of organic matter. It has been found that the easiest way to make wood more permeable for preservatives is to season it thoroughly, either by ordinary air seasoning or by kiln drying.

The wood should be cut, so far as possible, in the winter period, that is, between October and March. Where possible the bark should be removed, which will not only hasten the seasoning, but will also lessen, if not prevent, insect attack. After the wood has been cut it should be piled in such a way as to allow the greatest amount of air circulation between the various pieces. This holds good whether the wood be for fence posts, telegraph poles, or rail-

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road ties, or is in the form of sawed lumber. During the seasoning process not only does the water evaporate from the timber, but the various starches and albuminous substances are broken down, correspondingly increasing the penetrability of the wood.

The method of piling will depend largely upon the prevalent climatic conditions. In general, however, in extremely dry countries the timber will have to be piled more closely than in rainy countries, to prevent the too rapid drying out and consequent checking of the wood. In rainy countries excellent results have been obtained by building piles so that the upper pieces form a roof.

The length of time which is necessary to air-season wood varies with the climate and the season of the year. The tables following

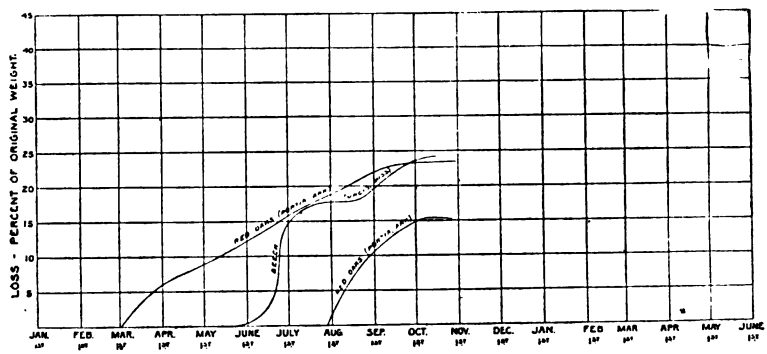

FIG. 47.—Rate of seasoning of red oak.

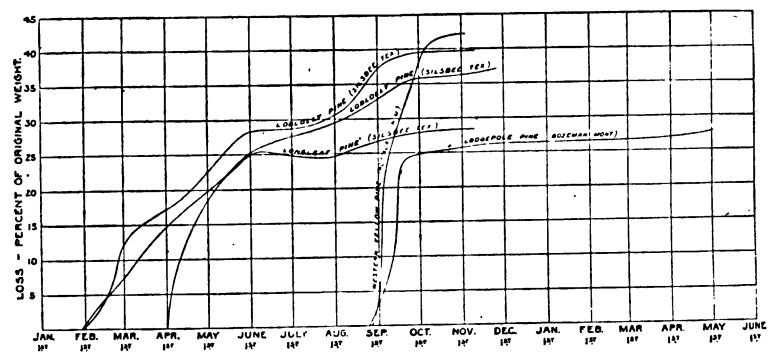

FIG. 48.—Rate of seasoning of loblolly, longleaf, and lodgepole pines.

and the diagrams (figs. 47 and 48) show this graphically. The curves in the diagrams show the rate of seasoning during the past year of red oak timber in Arkansas, loblolly and longleaf pines in Texas, and lodgepole pine in Montana.

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Weights at successive dates of red oak ties cut in June, 1903, at Portia, Ark.

Date of weighing.	Average weight per tie.	Loss.
	Pounds.	*Per cent.*
June 30	184.5	.....
July 18	172.4	6.6
July 28	170.58	7.5
September 10	162.09	12.1
September 20	154.75	16.1
October 28	154.35	16.3

In Central New Mexico, where the climate is very dry and hot during the summer, timber dries with great rapidity, as indicated in the following tables:

Weights at successive dates of red pine ties cut in August, 1903, at Rociada, N. Mex.

Date of weighing.	Average weight per tie.
	Pounds.
August 18	184.0
September 3	124.8
September 18	112.1
October 9	107.5
November 5	106.4

Per cent of loss November 5, 42.2.

Weights at successive dates of black pine ties cut in August, 1903, at Rociada, N. Mex.

Date of weighing.	Average weight per tie.
	Pounds.
August 26	164.8
September 3	127.8
September 18	103.0
October 9	96.0
November 6	93.7

Per cent of loss November 6, 43.1.

The cost of holding wood while seasoning is at best a very small one, and in view of the very much improved treatment possible when wood is seasoned this cost need hardly be considered.

TREATMENT OF TIMBER.

The treatment of wood falls into several classes, according to the manner in which the preservative is applied.

Where but few pieces are to be treated, the preservative is often applied to the outside of the wood, either with a brush or by dipping

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into the preservative. When wood is absolutely dry it will, in many instances, absorb in this way sufficient quantities of preservatives having any penetrating power, such as tar oils, spirittine, carbolineum, etc. These substances are excellent preservatives, and can be used to protect fence posts, car lumber, sills, and other structural timbers. Great care must be taken, however, that the wood is absolutely seasoned. All tar-oil products should be applied hot. Of the numerous products now being sold, for which the claim is made that they preserve wood absolutely by painting, only a very small number are of any value. Spirittine, carbolineum, and ordinary gas tar may be counted on as excellent wood preservers.

CORROSIVE SUBLIMATE.

The corrosive sublimate method of treating timber consists in immersing the wood in a solution of mercuric chlorid for a period sufficiently long to permit of more or less thorough penetration of the preservative. Excellent results have been obtained by soaking wood in a solution of corrosive sublimate (mercuric chlorid). This process has been extensively used in Europe for many years, particularly for smaller pieces of wood, such as posts, stakes, boards, etc.

The method of operation is extremely simple, and the original cost of the necessary apparatus is very small. A tank or vat is constructed of thick planks, carefully joined together so as to make the tank watertight. No iron must be used in building this vat, since it is quickly destroyed by the mercuric chlorid solution. The wood to be treated, which ought to be seasoned, is piled in this vat, and when the latter is almost full, by means of a series of clamps the wood is held firmly in position. The corrosive sublimate solution is then run in through wooden pipes from a neighboring storage tank, made also of wood. The solution is made by using one part of sublimate to 150 parts of water, the salt being first dissolved in a small quantity of hot water and then diluted to the proper point. The strength of the solution decreases as it is used, and must, therefore, be renewed by adding more sublimate from time to time. The liquid should stand in the vat so that it covers the wood at least an inch. As light affects the solution, it must be kept out by some sort of roof. The wood is left in the vats for from five to ten days, according to the size of the timber. Time should be given for thorough absorption by the wood before it is

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removed. After the solution has penetrated for a sufficient distance into the timber, the wood is taken out and dried. As the sublimate is comparatively insoluble in water, it remains in the timber for a very much longer time than salts like copper sulphate or zinc chlorid.

Wood treated in this way can be employed with comparative safety for fence posts, stakes for grapevines, etc. The cost of treatment is about 4½ cents per cubic foot of wood. In view of the small expense involved in putting up an apparatus to treat with this process, and the comparatively good results obtained, it is somewhat surprising that it has not been more generally employed by persons using small quantities of timber, who could not put up an expensive cylinder apparatus, such as is required for treatment with tar oil or zinc chlorid.

Caution.—Corrosive sublimate, or mercuric chlorid, is extremely poisonous, and care should be taken to prevent unnecessary handling of the solution, especially by persons not familiar with its character. In case of poisoning, the patient should at once drink milk in large quantities, or water in which well-beaten fresh eggs have been stirred—two to three eggs to a quart of water.

TAR-OIL VAT.

In many instances small pieces of timber, such as fence posts, grape-vine stakes, etc., can be treated with tar oil very much after the principle of the corrosive sublimate treatment. A small steel tank is used in many parts of Europe for this purpose. This tank is set in masonry in such a way that a fire can be built under it. Tar oil is poured into the tank, the posts or poles are set vertically in it, and a fire is started under it. As soon as the oil becomes thoroughly warm it penetrates into the timber for smaller or greater distances. Experiments on a considerable scale are now under way in this country to determine the exact length of time necessary to bring about a certain penetration, particularly with reference to fence posts. It is expected that preliminary results will be available in the course of three or four months. Attention should be called to the fact that treatment of this kind is possible only with absolutely dry wood.

TIMBER-PRESERVING PLANTS.

Where large quantities of timber are used, expensive and complicated preserving plants have to be built. These consist of steel

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cylinders in which the timber is placed. The preserving solution is then pumped in and forced into the wood either under pressure or by boiling. Preserving plants of this kind are now being operated at a large number of points in the United States. Such plants should preferably be located at some point where large tracts of land can be purchased cheaply, so as to give enough room for piling to permit of the timber being properly seasoned. On that account it is generally poor policy to construct a plant of this character in or near a large city. Locating the plant at or near the center of the district from which the timber is obtained will not only prevent long shipments, but also will considerably reduce the cost of handling. The size of plant will depend largely upon the amount of timber to be treated.

The statement on the following page is a general estimate of the approximate cost of preserving plants of different tie-treating capacities. This will, of course, vary with the price of land, cost of steel, etc.

Approximate cost of timber-preserving plants of different capacities.

250,000 ties per year	$40,000 to $50,000
500,000 ties per year	50,000 to 60,000
1,000,000 ties per year	90,000 to 125,000

The majority of treating processes, with the exception of those noted below, use a similar form of apparatus, composed of a closed cylinder with a movable door, pumps, tanks, etc. The piping and the pressure limit of the cylinder may differ somewhat in minor details, but the same cylinder can be used both for zinc chlorid treatment and for the creosote treatment.

COST OF VARIOUS TREATMENTS.

The choice of the kind of treatment to be used will depend (1) on the original cost of the wood; (2) on the cost of treatment; (3) on the increased length of life obtained. Detailed accounts of the methods of treatment will be found elsewhere. At the present time it is of interest, however, to compare briefly the cost of the various treatments. For this purpose the cost of treating railroad ties is taken as a standard, since more attention is now being paid to them than to other classes of material.

CREOSOTING.

Creosoting, as it has been done in the past, is the most efficient and satisfactory method of preserving timber. Well-creosoted wood

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is known to last indefinitely. Where a high-grade oil is used this treatment will in the long run prove the most satisfactory. At the same time it costs approximately 90 cents to $1 to obtain a creosoted yellow pine tie. The scarcity of creosote, as well as its high price, has prevented its general adoption, but investigations are now under way to secure new sources of supply of this valuable material.

If we compare the actual cost of untreated white oak and creosoted red oak or creosoted loblolly pine, assuming that the untreated tie lasts ten years and creosoted tie twenty, we may establish the following:

Cost of untreated white oak and of creosoted red oak or loblolly pine ties.

Cost of tie and annual charge.	Untreated white oak (10 years' life).	Creosoted red oak or loblolly pine (20 years' life).
Cost of tie	$0.85	$0.40
Cost of treatment		.45
Total cost of tie	.85	.85
Annual charge on a basis of 4 per cent compound interest	.105	.063
Annual charge for renewal at a cost of $0.19 for handling and placing	.016	.006
Total annual charge	.121	.069

The annual charges of untreated white oak, untreated red oak, and treated red oak are as follows:

For a white oak tie lasting 10 years	$0.121
For a red oak tie lasting 5 years	.124
For a red oak tie creosoted, lasting 20 years	.069

These figures show that there is at this time a considerable saving in using creosoted inferior timbers, and this saving will probably increase as the years go on because of the appreciation in price of white oak, longleaf pine, and other high-grade timbers.

Where oil is used, success is possible only with a good grade of tar oil. To secure this, it is important to have some system of inspection which can be applied to every shipment, which shall be as simple as possible, and which shall effectively test the quality of the oil. The following specifications are now being urged for general adoption by the Bureau of Forestry, and indicate what is considered a high-grade oil by the best European standards:

(1) The tar oil must be clear, that is, there must be no sub-

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stances in suspension. This is best tested by putting a drop of the oil on a piece of filter paper.

(2) The specific gravity must be about 1.04 to 1.10 at a temperature of 20° C. The boiling points must be as follows: Up to 150° C. nothing must come off; up to 200° C. not more than 10 per cent. may come off; up to 235° C. not more than 25 per cent. may come off; up to 355° C. at least 90 per cent. must come off.

(3) The oil must be soluble in benzine or in absolute alcohol.

Attention is called to the fact that specifications 1 and 2 apply only to oils which are completely liquid at 68° F. (20° C.). Certain high-grade oils made in this country contain amounts of naphthalene and anthracene which render them solid at the temperature above mentioned. The specific gravity of such oils should be taken at 2° above their melting point. It has been found that some of these oils also contain a small amount of matter which is not soluble in benzene or absolute alcohol. This is probably due to the presence of small amounts of free carbon. The presence of one-half of 1 per cent. of such insoluble matter should not serve as a sufficient cause for the rejection of the oil. In making use of benzene as a solvent the insoluble portion counted should not include water, which in itself will not dissolve in or mix with benzene. On account of local conditions governing the supply and manufacture of creosote oils, the rejection of any oils should not be made on account of slight variations from the specifications.

Creosoting as it is now conducted in the United States consists of several operations. In the first place the timber is steamed, so as to allow the preserving fluid to penetrate into the wood more readily. The creosote is then forced into the wood under pressure. One operation takes from eight to twenty-four hours. It has repeatedly been urged by the Bureau of Forestry that when timber is thoroughly seasoned there will be no necessity for the steaming operation. In none of the European creosoting plants is steaming resorted to, and their results as regards the length of life are certainly beyond dispute. Recent tests made with creosote, and also with zinc chlorid solution, a substance of far less penetrating power than creosote, have borne out this contention in every respect, and it is urged that wherever possible the steaming operation should be omitted.

At the present time several new processes for forcing creosote

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into the wood are being tried. Their purpose is largely to permit of a more economical use of this expensive material. While it is yet too early to give a definite statement as to their value, they may be briefly mentioned.

THE RUPING PROCESS.

The Rüping process consists in forcing air into absolutely seasoned wood at a pressure of about five atmospheres. Without relaxing this pressure the creosote is forced in at a higher pressure, and a pressure of twelve to fourteen atmospheres is then maintained for several hours. When the wood has absorbed a sufficient quantity of tar oil all pressure is released. The excess tar oil in the wood is then forced out by the compressed air in it. The total quantity of tar oil absorbed by the wood under this method is very much less than with the ordinary system. Extensive tests are now under way to determine exactly how much of a saving can be effected by the use of this process, which promises to be very successful. It seems very probable at this date that the process can be carried out with very much lower pressures.

VACUUM STEAM PROCESS.

A process is now being tried in Europe which has so far shown excellent results in an experimental way. Absolutely dry wood is placed in a cylinder, and tar oil at a temperature of 70° to 80° C. is run into the cylinder. The oil is left in the cylinder from ten to fifteen minutes, during which time a small quantity is absorbed by the wood. The oil is then pumped out and a high vacuum is maintained for about an hour. At the end of this period steam under pressure of two atmospheres is introduced into this vacuum for one to one and one-half hours. The object of this steaming is to cause the small amount of oil which is forced into the wood at first to be more evenly distributed throughout the entire piece. The absorption of oil is extremely variable, depending upon the amount of sapwood in the timber. The process consists in the omission of the vacuum. A small quantity of oil is first pressed into the wood, the oil is then run out of the cylinder, and steam is admitted into the cylinder directly after this operation. This also is still in the experimental stage.

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ZINC CREOSOTE PROCESSES.

Efforts are still being made in the direction of preventing the leaching out of zinc chlorid by adding tar oil to the zinc chlorid solution. The so-called Rütgers emulsion process is still used in Germany, but there is considerable objection to it because of the unequal distribution of the tar oil in the cylinders, the pieces of wood at the bottom of the cylinder receiving large quantities of oil while those near the top receive very small quantities.

Certain variations are now being tried by the Berliner Holzcomptoir, who add about 5 per cent. of wood tar, obtained from the distillation of beech wood, to the ordinary tar oil. This is said to make an emulsion with zinc chlorid of a more or less permanent character. In this country the injection of zinc chlorid, followed by tar oil (the Allardyce process), is being used to a certain extent with excellent results. The difficulty with all mixtures of zinc and tar oil is that with a single operation a poor tar emulsion is likely to result, while a double operation makes the treatment more expensive.

The cost of treating a tie with zinc creosote, as compared with the cost of an untreated tie, ignoring tie-plates, and estimating the life of the treated tie at sixteen years, may be given as follows:

Cost of untreated ties and of ties treated with zinc creosote.

Cost of tie and annual charge.	Untreated tie (5 years' life).	Treated tie (16 years' life).
Cost of tie	$0.40	$0.40
Cost of treatment		.25
Total cost of tie	.40	.65
Annual charge on a basis of 4 per cent compound interest	.089	.056
Annual charge for renewal at a cost of $0.19 for handling and placing	.085	.009
Total annual charge	.124	.065

THE SUGAR TREATMENT (POWELLIZED WOOD).

During the past summer an English inventor brought forward a process for treating timber with a strong sugar solution. The wood to be treated is boiled in the solution by introducing steam into a tank, which need not necessarily be a closed one. The boiling stops when all the air has been driven out of the wood. After treating the wood in the tank, it is dried gradually for several days,

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special care being taken to prevent too rapid evaporation. Three points are claimed for the invention: (1) That the process renders timber tougher and stronger; (2) that green timber can in this way be rapidly seasoned; (3) that the timber is to a certain extent rendered decay proof.

It is probable that this process will prove valuable in the treatment of timber for purposes which will not expose it to moisture. Investigations to determine its actual value are now in progress.

ZINC CHLORID TREATMENT.

The cheapest preserving process, and the one most universally employed in this country, is the treatment with zinc chlorid. The great difficulty with this salt is that it leaches out so rapidly from the wood. Numerous improvements in the manner of treating wood with zinc chlorid have been made in the last year. It has been found that by using absolutely seasoned wood it is possible to treat certain kinds of wood by introducing the zinc chlorid solution directly into the tie without the preliminary and customary steaming. In this connection it is important to remember that the principal object sought is to obtain the greatest possible penetration of the preservative. The amount of dry chlorid absorbed can be regulated easily enough by varying the strength of the solution. For the present the customary 2½ per cent. solution is recommended.

The following shows the result of some tests made at the Las Vegas treating plant of the Santa Fe Railway, and may serve as an illustration of the subject just referred to:

RECORD AND RESULTS OF RUN.

Vacuum begun	5.50 p. m.
21 inch vacuum	6.50 p. m.
$ZnCl_2$ pumped in	6.50 p. m.
80 pounds pressure reached at	7.15 p. m.
Started forcing back	10.15 p. m.
Completed	10.33 p. m.

Ties weighed morning after treatment.

Total weight of ties before treatment (118 ties used), pounds	10,602.5
Average weight of ties before treatment, pounds	89.9
Total weight of ties after treatment (without steaming) pounds	21,396.5
Average weight per tie after treatment, pounds	181.3
Gain per tie, per cent	101.7

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If we compare the cost of inferior timber ties, estimating their life at five years, with that of the same kind treated with zinc chlorid, making the very safe assumption of a ten years' life for them, and again with the same number of ties made from a long-lived timber, untreated, estimated as giving ten years' service, we get the following approximate figures:

Cost of treated and untreated ties of inferior timber and of untreated ties of long-lived timber.

Cost of tie and annual charge.	Untreated tie.		Treated tie.
	Inferior timber (5 years' life).	Long-lived timber (10 years' life).	Inferior timber (10 years' life).
Cost of tie	$0.40	$0.85	$0.40
Cost of treatment			.16
Total cost of tie	.40	.85	.56
Annual charge on a basis of 4 per cent compound interest	.089	.105	.069
Annual charge for renewal at a cost of $0.19 for handling and placing	.035	.016	.016
Total annual charge	.124	.121	.085
Annual charge for 500,000 ties	62,000	60,500	42,500

The principal points considered may be briefly summed up as follows:

(1) It is more profitable to treat inferior, cheap timbers, such as loblolly pine and red oak, than longleaf pine and white oak, as the latter timbers take treatment very poorly.

(2) It will pay better in the long run to treat these inferior timbers with a preservative, for the annual charge is thereby brought down to a lower point than when untreated timbers are used.

(3) All timbers should be thoroughly seasoned before being treated. Seasoned timber not only takes treatment better and consequently has longer life, but it is also easier to handle.

(4) For the present, the following preservatives are recommended:

For Fence Posts.—Fence posts, if they are to be preserved, can be either charred or treated when absolutely dry with such substances as carbolineum, spirittine, or tar oil. They can also be soaked in corrosive sublimate. Telegraph and telephone poles can likewise be treated by applying hot tar oil, carbolineum, or spirittine.

For Structural Timber.—When structural timber is to be used in large quantities, and where the odor is not objectionable, this

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class of material should be treated with creosote, using about ten pounds of tar oil per cubic foot. Where only a slight protection is necessary, tar-oil products can be applied from the outside provided the wood is absolutely dry.

For Ties.—The treatments recommended for ties at present are three: Creosoting.—The creosote should be of a high grade, as per specifications already given. About ten pounds of oil should be used per cubic foot. Zinc Chlorid.—Zinc-chlorid treatment is the cheapest recommended at the present time, and the only modification suggested as to its use is the omission of the steaming stage whenever, after sufficient trial, it is found that this can safely be done. Zinc Chlorid and Tar Oil.—The treatment of porous timber with zinc chlorid, followed by a treatment of three pounds of tar oil, is recommended as a process which will give good results. It is probable that within the next six months one or another of the new processes will have been tested sufficiently to warrant its being recommended.

For Piling.—The only treatment recommended for piling is the tar-oil treatment. This is true whether the pile is to be used in structural work on land or for marine work. The only difference between the two is that piling used in marine work ought to have very much more tar oil. The following quantities of tar oil per cubic foot of timber are recommended: For use in fresh water, 16 to 18 pounds of tar oil; for salt water, in the latitude of New York, 12 to 14 pounds; between New York and Florida, about 20 pounds; and for Gulf points, 22 to 25 pounds. For Pacific coast points larger quantities of oil are required in northern latitudes than for Atlantic coast points; so at Seattle at least 20 to 22 pounds of oil per cubic foot should be used. The tar oil used for marine wash should have a high per centage of naphthalene.

In general, the porous woods should have preference. It will pay better in the long run to use treated loblolly pine for piling than longleaf pine. The unsatisfactory results obtained by many with creosoted piling can almost always be traced to poor treatment with poor material.

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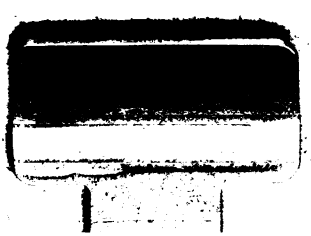

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